DOCUMENT RESUME

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PUB DATE	[82]
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IDENTIFIERS	*Millwrights; Power Plant Operators; Power Plants

ABSTRACT

This packet of 11 learning modules on trade math is 1 of 6 such packets developed for apprenticeship training for millwrights. Introductory materials are a complete listing of all available modules and a supplementary reference list. Each module contains some or all of these components: goal, performance indicators, study guide (a check list of steps the student should complete), a vocabulary list, an introduction, information sheets, assignment sheet, job sheet, self-assessment, self-assessment answers, post-assessment, instructor post-assessment answers, and a list of supplementary references. Supplementary reference material may be provided. The 11 training modules cover linear measurement; whole numbers; addition and subtraction of common fractions and mixed numbers; multiplication and division of common fractions and whole and mixed numbers; compound numbers; percent; ratio and proportion; perimeters, areas, and volumes; circumference and area of circles; areas of plane figures and volumes of solid figures; and metrics. (YLB)

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ED254730

APPRENTICESHIP

MILLWRIGHT

RELATED TRAINING MODULES

16.1 - 16.11 TRADE MATH

CE041006

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APPRENTICESHIP

MILLWRIGHT
RELATED TRAINING MODULES

SAFETY

1.1 General Safety
1.2 Hand Tool Safety
1.3 Power Tool Safety
1.4 Fire Safety
1.5 Hygiene Safety
1.6 Safety and Electricity
1.7 Fire Types and Prevention
1.8 Machine Safeguarding (includes O&HA Handbook)

ELECTRICITY/ELECTRONICS

2.1 Basics of Energy
2.2 Atomic Theory
2.3 Electrical Conduction
2.4 Basics of Direct Current
2.5 Introduction to Circuits
2.6 Reading Scales
2.7 Using a V.O.M.
2.8 OHM'S Law
2.9 Power and Watt's Law
2.10 Kirchoff's Current Law
2.11 Kirchoff's Voltage Law
2.12 Series Resistive Circuits
2.13 Parallel Resistive Circuits
2.14 Series - Parallel Resistive Circuits
2.15 Switches and Relays
2.16 Basics of Alternating Currents
2.17 Magnetism

COMPUTERS

3.1 Digital Language
3.2 Digital Logic
3.3 Computer Overview
3.4 Computer Software

TOOLS

4.1 Boring and Drilling Tools
4.2 Cutting Tools, Files and Abrasives
4.3 Holding and Fastening Tools
4.4 Fastening Devices
4.5 Basic Science - Simple Mechanics
4.6 Fasteners

DRAFTING

5.1 Types of Drawing and Views
5.2 Sketching
5.3 Blueprint Reading/Working Drawings
5.4 Working Drawings for Machines and Welding
5.5 Machine and Welding Symbols
5.6 Blueprint Reading, Drafting: Basic Print Reading
5.7 Blueprint Reading, Drafting: Basic Print Reading
5.8 Blueprint Reading, Drafting: Basic Print Reading
5.9 Blueprint Reading, Drafting: Basic Print Reading
5.10 Blueprint Reading, Drafting: Basic Print Reading
5.11 Blueprint Reading, Drafting: Basic Print Reading
5.12 Blueprint Reading, Drafting: Basic Print Reading
5.13 Blueprint Reading, Drafting: Basic Print Reading
5.14 Drafting, Machine Features
5.15 Drafting, Measurement
5.16 Drafting, Visualization

HUMAN RELATIONS

6.1 Communications Skills
6.2 Feedback
6.3 Individual Strengths
6.4 Interpersonal Conflicts
6.5 Group Problem Solving
6.6 Goal-setting and Decision-making
6.7 Worksite Visits
6.8 Resumes
6.9 Interviews
6.10 Expectation
6.11 Wider Influences and Responsibilities
6.12 Personal Finance

BOILERS

7.1 Boilers - Fire Tube Types
7.2 Boilers - Watertube Types
7.3 Boilers - Construction
7.4 Boilers - Fittings
7.5 Boilers - Operation
7.6 Boilers - Cleaning
7.7 Boilers - Heat Recovery Systems
7.8 Boilers - Instruments and Controls
7.9 Boilers - Piping and Steam Traps

TURBINES

8.1 Steam Turbines - Types
8.2 Steam Turbines - Components
8.3 Steam Turbines - Auxillaries
8.4 Steam Turbines - Operation and Maintenance
8.5 Gas Turbines

PUMPS

9.1 Pumps - Types and Classification
9.2 Pumps - Applications
9.3 Pumps - Construction
9.4 Pumps - Calculating Heat and Flow
9.5 Pumps - Operation
9.6 Pumps - Monitoring and Troubleshooting
9.7 Pumps - Maintenance

COMBUSTION

10.1 Combustion - Process
10.2 Combustion - Types of Fuel
10.3 Combustion - Air and Fuel Gases
10.4 Combustion - Heat Transfer
10.5 Combustion - Wood

GENERATORS

11.1 Generators - Types and Construction
11.2 Generators - Operation

FEEDWATER

12.1 Feedwater - Types and Equipment
12.2 Feedwater - Water Treatments
12.3 Feedwater - Testing

AIR COMPRESSORS

13.1 Air Compressors - Types
13.2 Air Compressors - Operation and Maintenance

STEAM

14.1 Steam - Formation and Evaporation
14.2 Steam - Types
14.3 Steam - Transport
14.4 Steam - Purification

MISCELLANEOUS

15.1 Installation - Foundations
15.2 Installation - Alignment
15.3 Circuit Protection
15.4 Transformers
15.5 Trade Terms

TRADE MATH

16.1 Linear - Measure
16.2 Whole Numbers
16.3 Additional and Subtraction of Common Fraction and Mixed Numbers
16.4 Multiplication and Division of Common Fractions and Whole and Mixed Numbers

16.5 Compound Numbers
16.6 Percent
16.7 Ratio and Proportion
16.8 Perimeters, Areas and Volumes
16.9 Circumference and Wide Area of Circles
16.10 Area of Plane, Figures and Volumes of Solid Figures
16.11 Metrics

HYDRAULICS

17.1 Hydraulics - Lever
17.2 Hydraulics - Transmission of Force
17.3 Hydraulics - Symbols
17.4 Hydraulics - Basic Systems
17.5 Hydraulics - Pumps
17.6 Hydraulics - Pressure Relief Valve
17.7 Hydraulics - Reservoirs
17.8 Hydraulics - Directional Control Valve
17.9 Hydraulics - Cylinders
17.10 Hydraulics - Forces, Area, Pressure
17.11 Hydraulics - Conductors and Connectors
17.12 Hydraulics - Troubleshooting
17.13 Hydraulics - Maintenance

METALLURGY

18.1 Included are ILS packets:
W 3010
W 3011-1
W 3011-2
MS 9001 (1-3-4-8-9-6-7-5-2-9)
MS 9200, 9201

POWER DRIVES

19.1 101. A-B-C-D-E
102. C-D-E
103. B-C-D-E
104. A-C-E-F-G-H-I-J
107. A
108. A

WELDING

20.1 602. A-B-C-D-G-I-L-M
603. A-B-F-G-I
W. 3011-1 refer to Mettallurgy 18.1
WE. MA-18

MILLWRIGHT
SUPPLEMENTARY REFERENCE DIRECTORY

Note: All reference packets are numbered on the upper right-hand corner of the respective cover page.

Supplementary Packet #	Description	Related Training Module
1.8	Concepts & Techniques of Machine Safeguarding, U.S.D.L., O.S.H.A.	1.8 Machine Safeguarding
12.1	Correspondence Course, Lecture 1, Sec. 2, Steam Generators, Types of Boilers I, S.A.I.T., Calgary, Alberta, Canada	7.1 Boilers, Fire Tube Type
12.2	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Types of Boikers II, S.A.I.T., Calgary, Alberta, Canada	7.2 Boilers, Water Tube Type
12.3	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Boiler Construction & Erection, S.A.I.T., Calgary, Alberta, Canada	7.3 Boilers, Construction
12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fittings II, S.A.I.T., Calgary, Alberta, Canada	7.4 Boilers, Fittings
12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fitting I, S.A.I.T., Calgary, Alberta, Canada	7.4 Boilers, Fittings
12.5	Correspondence Course, Lecture 10, Sec. 2, Steam Generation, Boiler Operation, Maintenance, Inspection, S.A.I.T., Calgary, Alberta, Canada	7.5 Boilers, Operation
12.7	Correspondence Course, Lecture 3, Sec. 2, Steam Generation, Boiler Details, S.A.I.T., Calgary, Alberta, Canada	7.7 Boilers Heat Recovery Systems
		PUMPS
13.1	Correspondence Course, Lecture 9, Sec. 2, Steam Generator, Power Plant Pumps, S.A.I.T., Calgary, Alberta, Canada	9.1 Types & Classifications
13.2		9.2 Applications
13.4		9.4 Calculating Heat & Flow
13.6		9.6 Monitoring & Troubleshooting
13.7		9.7 Maintenance
13.3	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Pumps, S.A.I.T., Calgary, Alberta, Canada	9.3 Construction
13.5		9.5 Operation

Supplementary Packet #	Description	Related Training Module
14.3 12.8	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Steam Generator Controls, S.A.I.T., Calgary, Alberta, Canada	14.3 Steam Transport 7.8 Boilers, Instruments & Controls
14.4	Correspondence Course, Lecture 11, Sec. 2, Steam Generators, Piping II, S.A.I.T., Calgary, Alberta, Canada	14.4 Steam Purification
15.1	Correspondence Course, Lecture 1, Sec. 4, Prime Movers, & Auxiliaries, Steam Turbines, S.A.I.T., Calgary, Alberta, Canada	8.1 Steam Turbines, Types
15.2	Correspondence Course, Lecture 4, Sec. 3, Prime Movers, Steam Turbines I, S.A.I.T., Calgary, Alberta, Canada	8.2 Steam Turbines, Components
15.3	Correspondence Course, Lecture 2, Sec. 4, Prime Movers & Auxiliaries, Steam Turbine Auxiliaries, S.A.I.T., Calgary, Alberta, Canada	8.3 Steam Turbines, Auxiliaries
15.4	Correspondence Course, Lecture 6, Sec. 3, Prime Movers, Steam Turbine Operation & Maintenance, S.A.I.T., Calgary, Alberta, Canada	8.4 Steam Turbines, Operation & Maintenance
15.5	Correspondence Course, Lecture 8, Sec. 3, Prime Movers, Gas Turbines, S.A.I.T., Calgary, Alberta, Canada	8.5 Gas Turbines
16.2	Boilers Fired with Wood & Bark Residues, D.D. Junge, F.R.L., O.S.U., 1975	10.2 Combustion Types of Fuel
16.2	Correspondence Course, Lecture 5, Sec. 2, Steam Generators, Fuel Combustion, S.A.I.T., Calgary, Alberta, Canada	10.2 Combustion Types of Fuel
16.3	Correspondence Course, Lecture 5, Sec. 2, Plant Services, Fuel & Combustion, S.A.I.T., Calgary, Alberta, Canada	10.3 Combustion Air & Fuel Gases
17.1	Correspondence Course, Lecture 12, Sec. 3, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	12.1 Feedwater, Types & Operation
17.2	Correspondence Course, Lecture 12, Sec. 2, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	12.2 Feedwater, Water Treatments

Supplementary Packet #	Description	Related Training Module
17.3	Correspondence Course, Lecture 7, Sec. 2, Steam Generators, Boiler Feedwater Treatment, S.A.I.T., Calgary, Alberta, Canada	12.3 Feedwater, Testing
18.1	Correspondence Course, Lecture 2, Sec. 5, Electricity, Direct Current Machines, S.A.I.T., Calgary, Alberta, Canada	11.1 Generators, Types & Construction
18.1 18.2	Correspondence Course, Lecture 4, Sec. 5, Electricity, Alternating Current Generators, S.A.I.T., Calgary, Alberta, Canada	11.1 Generators, Types & Construction 18.2 Generators, Operation
19.1	Correspondence Course, Lecture 5, Sec. 4, Prime Movers & Auxiliaries, Air Compressor I, S.A.I.T., Calgary, Alberta, Canada	13.1 Air Compressors, Types
19.1	Correspondence Course, Lecture 6, Sec. 4, Prime Movers & Auxiliaries, Air Compressors II, S.A.I.T., Calgary, Alberta, Canada	13.1 Air Compressors, Types 13.2 Air Compressors, Operation & Maintenance
20.1	Basic Electronics, Power Transformers, EL-BE-51	15.4 Transformers
21.1	Correspondence Course, Lecture 6, Sec. 5, Electricity, Switchgear & Circuit, Protective Equipment, S.A.I.T., Calgary, Alberta, Canada	15.3 Circuit Protection
22.1	Correspondence Course, Lecture 10, Sec. 3, Prime Movers, Power Plant Erection & Installation, S.A.I.T., Calgary, Alberta, Canada	15.1 Installation Foundations

RECOMMENDATIONS FOR USING TRAINING MODULES

The following pages list modules and their corresponding numbers for this particular apprenticeship trade. As related training classroom hours vary for different reasons throughout the state, we recommend that the individual apprenticeship committees divide the total packets to fit their individual class schedules.

There are over 130 modules available. Apprentices can complete the whole set by the end of their indentured apprenticeships. Some apprentices may already have knowledge and skills that are covered in particular modules. In those cases, perhaps credit could be granted for those subjects, allowing apprentcies to advance to the remaining modules.

We suggest the the apprenticeship instructors assign the modules in numerical order to make this learning tool most effective.

SUPPLEMENTARY INFORMATION

ON CASSETTE TAPES

Tape 1: Fire Tube Boilers - Water Tube Boilers and Boiler Manholes and Safety Precautions

Tape 2: Boiler Fittings, Valves, Injectors, Pumps and Steam Traps

Tape 3: Combustion, Boiler Care and Heat Transfer and Feed Water Types

Tape 4: Boiler Safety and Steam Turbines

NOTE: The above cassette tapes are intended as additional reference material for the respective modules, as indicated, and not designated as a required assignment.

Modules 18.1, 19.1, and 20.1 have been omitted because they contain dated materials.

16.1

LINEAR -- MEASUREMENT

Goal:

The apprentice will be able to use the concepts of linear measurement.

Performance Indicators:

1. Read linear measurement to 1/32".

Introduction

MATH

LINEAR MEASUREMENT

Fundamental to any industrial vocation is the measurement of linear or straight line distances. These measurements may be expressed in one of two systems. Apprentices for the most part still use the more familiar British system (of which the yard is the standard unit of length) although the metric is rapidly gaining popularity in the United States. The problems in this module will assume the use of the British system.

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

1. ____ Familiarize yourself with the Goal and Performance Indicators on the title page of this module.

2. ____ Read the Introduction and study the Information section of the module. It is intended to provide you with the math skills necessary to sucessfully complete the assessment portions.

3. ____ Complete the Self Assessment section of the module. You may refer to the Information section for help.

4. ____ Compare your Self Assessment answers with the correct answers on the Self Assessment Answer Sheet immediately following the Self Assessment exam. If you missed more than one of the Self Assessment exam questions, go back and re-study the necessary portions of the Information section, or ask your instructor for help. If you missed one or none of these problems, go on to step 5.

5. ____ Complete the Post Assessment section of the module. Show your answers to the instructor. It is recommeneded that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on the next math module.

Information

TABLE OF LINEAR MEASURE

12 inches	= 1 foot
3 feet	= 1 yard
5 1/2 yards	= 1 rod
40 rods	= 1 furlong
8 furlongs	= 1 mile

Apprentices have as a basic tool, a steel rule that measures to the nearest one-thirty-second (1/32") of an inch. In most shops a tolerance of 1/32" is allowed im most measurements.

To read measurements, merely calculate where on the rule the mark falls.

Self Assessment

Read the distance from the start of the ruler to the letters A through O to the nearest 1/32" and place your answers in the assigned space below.

A= _____ F= _____ K= _____

B= _____ G= _____ L= _____

C= _____ H= _____ M= _____

D= _____ I= _____ N= _____

E= _____ J= _____ O= _____

Self Assessment Answers

A. 6/8 = 3/4

B. 1 1/2

C. 2 1/8

D. 3 1/16

E. 3 3/8

F. 3 3/4

G. 4 5/16

H. 3/32

I. 17/32

J. 1 15/32

K. 2 15/32

L. 2 31/32

M. 3 3/8

N. 3 9/16

O. 4 1/32

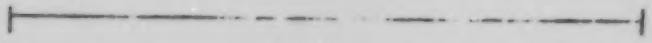
Post Assessment

Find the length of each of the following line segments to the nearest 1/32".
(Always measure from the inside of end mark on the line segments.)

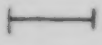
A)

B)

C)



D)



E)

A =

B =

C =

D =

E =

Draw a line segment equal to each of the following lengths to the nearest 1/32". Use the given end mark as the left end mark for the segment.

Example: 3"

A) 3 1/2"

B) 6 1/8"

C) 4 3/32"

D) 1 5/8"

E) 5 5/16"

F) 7/16"

G) 1/2"

H) 3/4"

I) 4/36"

J) 6/8"

16.2

WHOLE NUMBERS

Goal:

The apprentice will be able to compute with whole numbers.

Performance Indicators:

1. Add whole numbers.
2. Subtract whole numbers.
3. Multiply whole numbers.
4. Divide whole numbers.

Introduction

If an apprentice in any of today's skilled trades is to achieve his or her goal of becoming a top-flight journeyman, he or she must have a good working knowledge of basic mathematics. Problems involving common and decimal fractions, percent, ratio and proportion, compound numbers, and areas and volumes are regularly encountered in the trades. Because of their importance to the apprentice, these basic concepts are taken up in turn in subsequent modules of this unit. The present module provides a review of the addition, subtraction, multiplication and division of whole numbers--numbers that do not contain fractions and that are not in themselves fractions.

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

1. ____ Familiarize yourself with the Goal and Performance Indicators on the title page of this module.

2. ____ Read the Introduction and study the Information section of the module. It is intended to provide you with the math skills necessary to successfully complete the assessment portions.

3. ____ Complete the Self Assessment section of the module. You may refer to the Information section for help.

4. ____ Compare your Self Assessment answers with the correct answers on the Self Assessment Answer Sheet immediately following the Self Assessment exam. If you missed more than one of the Self Assessment exam questions, go back and re-study the necessary portions of the Information section, or ask your instructor for help. If you missed one or none of these problems, go on to step 5.

5. ____ Complete the Post Assessment section of the module. Show your answers to the instructor. It is recommended that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on to the next math module.

Information

WHOLE NUMBERS

A whole number is any one of the natural numbers such as 1, 2, 5, etc. Numbers represent quantities of anything. They can be added, subtracted, multiplied or divided.

ADDITION

Addition is the process of combining two or more quantities (numbers) to find a total. The total is called the sum. Addition is indicated by the plus (+) sign and may be written as 2 + 2. The sum may be indicated by using the equal (=) sign. Example: 2 + 2 = 4. Another way of writing the same thing showing the sum of 4 is:

$$\begin{array}{r} 2 \\ +\ 2 \\ \hline 4 \end{array}$$

The following problem is included to refresh your memory of basic addition in trade terms.

ADDITION PROBLEM

Three bricklayers working together on a job each laid the following number of brick in one day. First bricklayer laid 887, second bricklayer laid 1123, and the third bricklayer laid 1053 brick. How many brick did all three lay that day?
Answer: 887 + 1123 + 1053 = 3063 brick

SUBTRACTION

Subtraction is the process of taking something away from the total. The portion which is left after taking some away is called the difference. The sign which indicates that one quantity (number) is to be subtracted from another is the minus (-) sign. Example: 6 - 4. In this example, 4 is being subtracted from 6. The difference is 2 or 6 - 4 = 2. Another way of writing the same thing is:

$$\begin{array}{r} 6 \\ -\ 4 \\ \hline 2 \end{array}$$

SUBTRACTION PROBLEM

A mason ordered 75 bags of cement and used 68 bags on the job. How many bags of cement were left?

Answer: 75 - 68 = 7 bags

MULTIPLICATION

Multiplication is the process of repeated addition using the same numbers. For example, if 2 + 2 + 2 + 2 + 2 were to be summed, the shortest method would be to multiply 5 times 2 to get the total of 10. The sign used to indicated multiplication is the times (x) sign. In the previous example, 5 times 2 equals 10, would be written 5 x 2 = 10. This may also be written as:

$$\begin{array}{r} 2 \\ \times\ 5 \\ \hline 10 \end{array}$$

MULTIPLICATION PROBLEMS

If a bricklayer can lay 170 brick an hour, how many brick would be laid in four hours?

Answer: 170 x 4 = 680 brick

One type of brick cost $9 per hundred. If 14,000 brick were ordered, how much would they cost?

Answer: $9 x 140 = $1260. Note: The brick were 9¢ each, $9 per hundred or $90 per thousand. Therefore, the answer could have been determined by multiplying 9¢ x 14,000, $90 x 14 or $9 x 140.

DIVISION

Division is the process of finding how many times one number is contained within another number. The division symbol is (÷). For example, when we wish to find how many times 3 is contained in 9, we say 9 divided by 3 equals 3 or 9 ÷ 3 = 3. The answer is called the quotient. If a number is not contained in another number an equal number of times, the amount left over is called the remainder. The following

problem illustrates such a situation: $9 \div 4 = 2$ with 1 left over. For purposes of calculation, the problem is generally written this way:

$$4\overline{)9}\ \begin{matrix}2\\8\\\hline 1\end{matrix}$$ or 2 1/4 remainder

DIVISION PROBLEMS

If a set of steps had 8 risers and the total height of all the steps (total rise) was 56 in., what would the height of each step be?

Answer:
$$8\overline{)56}\ \begin{matrix}7\end{matrix}$$ or 7 in.

If a brick veneer wall requires five brick to lay up 1 sq. ft., how many square feet would 587 cover?

Answer: 117 2/5 sq. ft. of wall

$$5\overline{)587}\ \begin{matrix}117\\5\\\hline 8\\5\\\hline 37\\35\\\hline 2\end{matrix}$$

Self Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the blank space to the left of the problem.

1. ____ The estimated cost of a roof on a small building was $1,553. The actual cost was $1,395. What was the amount saved?

   a. $146
   b. $158
   c. $168
   d. $185

2. ____ A contractor buys 637 ft. of eaves trough for a four-family apartment. On completion of the job, he finds he has 48 ft. of the trough left. How many feet of the material has been used?

   a. 569
   b. 578
   c. 589
   d. 598

3. ____ A contractor buys 400 sacks of rock for three different jobs. On the first job he uses 78 sacks; on the second, 85 sacks; and on the third, 205 sacks. How many sacks are left?

   a. 30
   b. 31
   c. 32
   d. 33

4. ____ A contractor's bid on a school building is $78,265. When one wing is omitted to cut costs, he is able to cut his bid by $16,228. What is the new figure?

   a. $60,039
   b. $61,038
   c. $62,037
   d. $63,063

5. ____ If a dealer gets a shipment of 24,000 lbs. of tile, how many tons does he receive?

   a. 12
   b. 24
   c. 120
   d. 240

6. ____ A roofer works 40 hours at $3.00 per hour and 10 hours at $4.00 per hour. How much does the roofer earn?

   a. $140
   b. $150
   c. $160
   d. $170

7. ____ If a bundle of rock lath weighs 35 lbs. and it is permissible to place 700 lbs. on any one area on a floor, how many bundles can be placed on any one area?

a. 20
b. 22
c. 24
d. 28

8. ____ If 5 lbs. of putty are required to install one light of glass, how many lights can be installed with 85 lbs?

a. 16
b. 17
c. 18
d. 19

Self Assessment Answers

1. b
2. c
3. c
4. c
5. a
6. c
7. a
8. b

SELF ASS
ANSWER

1 = b

2 = c

3 = c

4 = c

5 = A

6 = c

7 = A

8 = b

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the blank space to the left of the problem.

1. ____ 686 + 240 + 1,320 + 16 + 400 =

   a. 2,452 c. 2,662
   b. 2,653 d. 2,762

2. ____ 16 + 480 + 26 + 15 + 6,000 =

   a. 6,436 c. 6,536
   b. 6,437 d. 6,537

3. ____ 29 + 15 + 24 + 13 + 10 =

   a. 90 c. 92
   b. 91 d. 93

4. ____ 280 - 116 =

   a. 154 c. 164
   b. 163 d. 174

5. ____ 40 - 16 =

   a. 21 c. 23
   b. 22 d. 24

6. ____ 220 - 38 =

   a. 172 c. 181
   b. 173 d. 182

7. ____ 292 x 16 =

   a. 3,573 c. 4,672
   b. 3,772 d. 4,772

8. ____ 460 x 15 =

   a. 5,900 c. 7,900
   b. 6,900 d. 8,900

9. ____ 24 ÷ 6 =

a. 2
b. 4
c. 6
d. 8

10. ____ 180 ÷ 5 =

a. 32
b. 34
c. 36
d. 38

16.3

ADDITION AND SUBTRACTION OF COMMON

FRACTIONS AND MIXED NUMBERS

Goal:

The apprentice will be able to add and subtract common fractions and mixed numbers.

Performance Indicators:

1. Add fractions and mixed numbers.
2. Subtract fractions and mixed numbers.

Introduction

In solving the many kinds of mathematical problems that are encountered in the skilled trades, the mechanic will often find it necessary to work with fractions as well as whole numbers. The Information section for this topic introduces common fractions--fractions in which both the numerator and the denominator are expressed, as in 1/4, 3/8, or 11/32--and includes practice problems in the addition and subtraction of common fractions and mixed numbers (numbers that consist of whole numbers and fractions).

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

1. ____ Familiarize yourself with the Goal and Performance Indicators on the title page of this module.

2. ____ Read the Introduction and study the Information section of the module. It is intended to provide you with the math skills necessary to successfully complete the assessment portions.

3. ____ Complete the Self Assessment section of this module. You may refer to the Information section for help.

4. ____ Compare your Self Assessment answers with the correct answers on the Self Assessment Answer Sheet immediately following the Self Assessment exam. If you missed more than one of the Self Assessment exam questions, bo back and re-study the necessary portions of the Information section, or ask your instructor for help. If you missed one or none of these problems, go on to step 5.

5. ____ Complete the Post Assessment section of the module. Show your answers to the instructor. It is recommended that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on the next math module.

Information

FRACTIONS

A fraction is one or more parts of a whole. Fractions are written with one number over the other (1/2 or 1/4 or 3/4).

The top number is called the NUMERATOR and the bottom number is called the DENOMINATOR. The denominator identifies the number of parts into which the whole is divided. The numerator indicates the number of parts of the whole which is of concern. In reading a fraction, the top number is always read first. For example, 1/2 would be read "one half"; and 3/4 would be read "three fourths" and 3/8 would be read "three eighths."

A fraction should always be reduced to its lowest denominator. For instance, 3/2 is not in correct form. It should be 1 1/2 because 2/2 = 1 and 1 + 1/2 = 1 1/2. The 1 1/2 is called a MIXED NUMBER. Always when the numerator and denominator are the same number as 1/1, 2/2, 3/3, etc. they are equal to 1.

ADDING FRACTIONS

The easiest fractions to add are those whose denominators (bottom numbers) are the same, as 1/8 + 3/8. Simply add the numerators (top numbers) together and keep the same denominator. For example, 1/8 + 3/8 = 4/8 or 1/2. (Reducing the fraction to its lowest denominator is preferred.) Another example of reducing to the lowest denominator is 8/24 = 1/3, because 24 may be divided by 8 three times.

When fractions to be added have different denominators (bottom numbers), multiply both numerator and denominator of each fraction by a number that will make the denominators equal. For example: 1/3 + 3/5 = 5/15 + 9/15. Observation indicated that 15 was the smallest number that could be divided evenly by both denominators. To complete the example, 5/15 + 9/15 = 14/15. Therefore, the sum of 1/3 and 3/5 is 14/15.

PROBLEMS IN ADDING FRACTIONS

What is the height of one stretcher course of brick if the brick are 2 1/4 in. high and the mortar joint is 3/8 in?

Answers: 2 1/4 + 3/8 = 2 2/8 + 3/8 = 2 5/8 in. height for one course

A mason estimated the following amounts of mortar required for a job: 5 1/2 cu. yd., 11 1/3 cu. yd. and 6 1/4 cu. yd. What is total amount of mortar required for job?

Answer: 5 1/2 + 11 1/2 + 6 1/4

= 5 6/12 + 11 4/12 + 6 3/12

= 22 13/12 = 23 1/12 cu. yd. of mortar

SUBTRACTING FRACTIONS

Change all fractions to the same common denominator as was done for adding fractions. When the denominators are the same, subtract the numerators.

Self Assessment

Note: The value of a fraction is not changed when both the numerator and denominator are multiplied or divided by the same number.

Reduce to halves. (A denominator of 2)

4/8 = ___ 8/16 = ___ 16/8 = ___

Reduce to 8ths.

4/16 = ___ 16/32 = ___ 32/64 = ___

Note: Divide the numerator and denominator by the same number. When both the numerator and the denominator cannot be divided further by the same number, the fraction is expressed in its lowest terms.

Reduce to lowest terms:

4/16 = ___ 14/16 = ___ 28/64 = ___ 16/32 = ___ 12/16 = ___ 24/12 = ___

Note: To reduce an improper fraction (where the numerator is larger than the denominator) to its lowest terms, divide the numerator (above the line) by the denominator (below the line).

Reduce the resulting fraction to its lowest terms.

5/2 = ___ 10/3 = ___ 10/5 = ___

Note: To change a mixed fraction to an improper fraction, multiply the denominator by the whole number and add the numerator. Place the result over the denominator.

Change to improper fractions.

1 3/4 = ___ 8 7/8 = ___ 3 1/4 = ___ 10 2/3 = ___

How many eights of an inch are there in each of the following lengths of steel?

1 3/8" = ___ 4 3/8" = ___ 7 3/8" = ___

Note: The smallest number that can be divided by all the denominators is called the LOWEST COMMON DENOMINATOR.
To reduce fractions to the lowest common denominator, divide the number selected as the lowest common denominator by the denominator of each given fraction.
Multiply both the numerator and denominator by this quotient.

Note: To add fractions, change to fractions having a least common denominator. Add the numerators. Write the sum over the common denominator. Reduce the result to its lowest terms.

Addition of common fractions:

1/6 + 5/6 = ___ 1/3 + 1/16 = ___ 5/8 + 3/4 + 3/8 = ___

Addition of common fractions and mixed numbers:

121 + 7 5/12 = ___ 1 17/64 + 1 13/64 + 9/32 = ___

Note: To subtract a fraction from a whole number, take one unit from the whole number and change it into a fraction having the same denominator as the fraction which is to be subtracted. Subtract the numerators of the original fraction from the one unit that was changed to its fractional value. Reduce the resulting fraction to its lowest terms. Place the whole number next to the fraction.

```
 4      7
-3/4   -15/16
```

Note: To subtract a mixed number from a whole number, borrow one unit from the whole number and change it to a fraction which has the same denominator as the mixed number. Subtract the fraction part of the mixed number from the fraction part of the whole number. Subtract the whole numbers and reduce

the resulting mixed number to lowest terms.

2	3	27
-1 1/3	-1 3/8	-1 5/16

Note: To subtract two mixed numbers, change the fractional part of each mixed number to the least common denominator. Borrow one unit, when necessary, to make up a larger fraction than the one being subtracted. Subtract the fractions first, the whole numbers next, and reduce the result to lowest terms.

Note: To add and subtract fractions in the same problem, change all fractions to the least common denominator. Add or subtract the numerators as required. Reduce the result to lowest terms.

1 3/5	7 5/6	18 7/8
-1 1/5	-2 1/6	-9 3/8

Self Assessment Answers

Reduce to halves: 1/2 1/2 4/2

Reduce to 8ths: 2/8 4/8 4/8

Reduce to lowest terms: 1/4 7/8 7/16 1/2 3/4 2/1

Reduce the resulting fraction to its lowest terms: 2 1/2 3 1/3 2

Change to improper fractions: 7/4 71/8 13/4 32/3

How many eights of an inch are there in each of the following lengths of steel:
11 35 59

Addition of common fractions and mixed numbers: 128 5/12 2 48/64

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter of that answer in the blank space to the left of the problem.

1. ____ The improper fraction 48/32 expressed as a mixed number is:

   a. 1 15/32
   b. 1 1/2
   c. 1 5/8
   d. 2 1/32

2. ____ The mixed number 4 3/16 expressed as an improper fraction is:

   a. 16/8
   b. 43/16
   c. 67/16
   d. 35/8

3. ____ What is the least common denominator for the following group of fractions: 1/8, 1/2, 1/4 and 1/12

   a. 12
   b. 18
   c. 24
   d. 48

4. ____ What is the sum of the following fractions: 1/2, 1/3, 1/8 and 1/12?

   a. 1 3/12
   b. 1 1/12
   c. 1 1/24
   d. 1 1/48

5. ____ If 1/2 is subtracted from 7/8, the difference is:

   a. 3/8
   b. 5/8
   c. 1 1/8
   d. 1 3/8

6. ____ The sum of 1 1/2, 5/6, 14, and 20 2/3 is:

   a. 36 2/3
   b. 36 17/18
   c. 37
   d. 37 2/9

7. ____ One roof is 1/3 larger in area than another. The smaller roof takes 24 squares of roofing material. How many squares of roofing material will the larger roof take?

   a. 32
   b. 34
   c. 36
   d. 37

8. ____ One-third of a box of glass is needed to glaze the north elevation of a building; 2/3 of a box is needed to glaze the south elevation; 1/6 of a box is needed to glaze the east elevation; and 1/2 of a box is needed to glaze the west elevation. How many boxes are needed to glaze all four elevations?

a. 1 1/6
b. 1 1/3
c. 1 1/2
d. 1 2/3

9. ____ From a bundle containing 101 linear feet of molding, a cabinetmaker uses the following amounts: 11 1/2', 8 3/4', 12 1/8' and 9 5/8'. How many linear feet of molding does he use in all?

a. 38 1/2
b. 39 1/4
c. 39 3/4
d. 41 5/6

10. ____ How many linear feet of molding remain in the bundle in problem 9?

a. 59 1/6
b. 61 1/4
c. 61 3/4
d. 62 1/2

11. ____ From a roll of hanger wire weighing 100 lbs., a lather uses the following amounts: 6 lbs., 18 1/2 lbs., 9 1/8 lbs., and 22 1/4 lbs. How many pounds of the wire does he use in all?

a. 54 1/4
b. 54 3/4
c. 55 1/4
d. 55 7/8

16.4

MULTIPLICATION AND DIVISION OF

COMMON FRACTIONS AND WHOLE AND MIXED NUMBERS

Goal:

The apprentice will be able to multiply and divide common fractions and whole and mixed numbers.

Performance Indicators:

1. Multiply fractions.
2. Divide fractions.
3. Multiply and divide problems that contains both fractions and whole and mixed numbers.

Introduction

The previous module reviewed the rules and procedures for some fundamental operations with common fractions: reduction of fractions, finding the lowest common denominator, and adding and subtracting fractions and mixed numbers. The study assignment for the present module concludes the review of common fractions, covering the rules and procedures for multiplying and dividing common fractions and common fractions in combination with whole numbers and mixed numbers.

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

1. ____ Familiarize yourself with the Goal and Performance Indicators on the title page of this module.

2. ____ Read the Introduction and study the Information section of this module. It is intended to provide you with the math skills necessary to successfully complete the assessment portions.

3. ____ Complete the Self Assessment section of the module. You may refer to the Information section for help.

4. ____ Compare the Self Assessment answers with the correct answers on the Self Assessment Answer Sheet immediately following the Self Assessment exam. If you missed more than one of the Self Assessment exam questions, go back and re-study the necessary portions of the Information section, or ask your instructor for help. If you missed one or none of these problems, go on to step 5.

5. ____ Complete the Post Assessment section of the module. Show your answers to the instructor. It is recommended that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on the next math module.

Information

MULTIPLYING FRACTIONS

The procedure for multiplying fractions is to multiply the numerators together to find the numerator for the answer. Then, multiply the denominators together to find the denominator for the answer. The answer is called a PRODUCT and the fraction is reduced to its lowest form. Example: 4 times 5/8 = 4/1 x 5/8 = 20/8 = 2 4/8 = 2 1/2.

PROBLEMS IN MULTIPLYING FRACTIONS

If standard brick are used which are 2 1/4 in. thick to lay a wall with 3/8 in. mortar joints, what will the height of the wall be after nine courses?

Answer: First, add the thickness of one mortar joint to the thickness of one brick (2 1/4" + 3/8" = 2 5/8"). Then multiply 2 5/8" times 9 to find the height. 2 5/8" x 9 = 21/8 x 9/1 = 189/8 = 23 5/8 in.

If a set of steps are five risers high and each riser is 7 1/4 in., what is the total rise of the steps?

Answer: 7 1/4 x 5/1 = 29/4 x 5/1 = 145/4 = 36 1/4 in.

What is the length of a 28 stretcher wall if each stretcher is 7 1/2 in. and the mortar joint is 1/2 in.?

Answer: 7 1/2" = 1/2" = 8"; 8" x 28" = 224"; 224" ÷ 12 = 18 2/3' (2/3 x 121 = 24/3 = 8 in.) Therefore the length is 18'8"

DIVIDING FRACTIONS

The process of dividing fractions is accomplished by inverting (turning up side down) the divsor and then multiplying. For example, 3/8 ÷ 3/4 is solved by changing the 3/4 to 4/3. Therefore, 3/8 ÷ 3/4 = 3/8 x 4/3 = 12/24 = 1/2.

PROBLEMS IN DIVIDING FRACTIONS

How many risers 7 1/2 in. high would be required to construct a flight of concrete steps 3' 1 1/2" high?

Answer: Change 3'1 1/2" to 37 1/2"; Divide 37 1/2" by 7 1/2; 75/2 ÷ 15/2 = 75/2 x 2/15 = 150/30 = 5 risers

If a brick mantel is corbeled out 4 1/2 in. in six courses, how much does each course project past the previous course?

Answer: 4 1/2 ÷ 6/1 = 9/2 x 1/6 = 9/12 = 3/4 in.

If a story pole was 8'11 1/2" long and divided into 39 equal spaces, what is the length of each space?

Answer: 8'11 1/4" ÷ 39 = 107 1/4' ÷ 39/1 = 429/4 x 1/39 = 429/156 = 2 117/156 = 2 3/4 in.

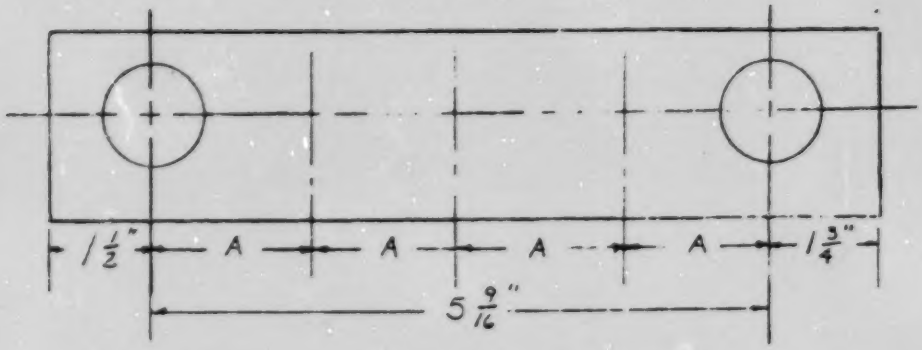
Self Assessment

How many pieces of 10 5/16" flat bar may be cut from a 12-foot piece of stock if you allow 3/16" for the kerf?

How many pieces of stock 7/8" long can be cut from a 30" bar of drill rod if 1/16" is allowed on each piece for kerf?

Determine center distance A.

A = _____



Self Assessment Answers

13 pieces of flat bar

32 pieces of stock

A = 1 25/64

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the blank space to the left of the problem.

1. ____ The product of 1/2 x 7/8 is:

   a. 1/8
   b. 5/16
   c. 7/16
   d. 1 1/8

2. ____ The product of 3/4 x 2/3 is:

   a. 5/12
   b. 1/2
   c. 5/7
   d. 8/9

3. ____ The quotient of 1/2 ÷ 1/4 is:

   a. 1/8
   b. 3/4
   c. 1
   d. 2

4. ____ The quotient of 1/4 - 1/2 is:

   a. 1/2
   b. 4/6
   c. 5/6
   d. 13/18

5. ____ The quotient of 1/4 ÷ 1/3 is

   a. 1/9
   b. 1/6
   c. 3/4
   d. 1 1/3

6. ____ If a roll of carpet weighs 467 1/2 lbs. and a running foot of the carpet weighs 2 1/8 lbs., how many running feet are in the roll?

   a. 200
   b. 220
   c. 374
   d. 935

7. ____ A type of linoleum weighs 1 5/6 lbs. per running foot. How many pounds does a roll containing 59 2/3 running feet weigh?

   a. 103 1/6
   b. 109 2/3
   c. 109 7/8
   d. 116 7/18

8. ____ A piece of pipe must be cut to 3/8 the length of another pipe, which is 9' long. How long a piece must be cut?

   a. 3 1/4'
   b. 3 3/8'
   c. 4 1/4'
   d. 4 3/8'

9. ____ What is the height of the second floor above the first if the stairway connecting the floors has 16 risers and each riser is 7 1/4" high?

a. 8'10"
b. 9'0"
c. 9'6"
d. 9'8"

10. ____ A truck rated at 1 1/2 tons is to be used to pick up surplus gravel at five local job sites and return it to the yard. The amount of surplus gravel at each site is as follows: job A, 3/4 ton; job B, 3/8 ton; job C, 1 7/8 tons; job D, 1 1/2 tons, and job E, 2 5/8 tons. How many trips to the yard must the truck make to return all the gravel?

a. 3
b. 4
c. 5
d. 6

16.5

COMPOUND NUMBERS

Goal:

The apprentice will be able to compute compound numbers.

Performance Indicators:

1. Reduce compound numbers.
2. Add compound numbers.
3. Subtract compound numbers.
4. Multiply compound numbers by whole numbers.
5. Divide compound numbers by whole numbers.
6. Add and subtract compound mixed numbers.

Introduction

Workers in the skilled trades frequently must solve problems involving the addition, subtraction, multiplication, and division of compound numbers, which are expressions containing two or more unlike but related units of measure, such as 6 ft. 2 in. or 4 lb. 3 oz. Each of the two or more parts of a compound number is called a denominate number. In the examples given above, 6 ft., 2 in., 4 lb., and 3 oz. are all denominate numbers.

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

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3. ____ Complete the Self Assessment section of the module. You may refer to the Information section for help.

4. ____ Compare your Self Assessment answers with the correct answers on the Self Assessment Answer Sheet immediately following the Self Assessment exam. If you missed more than one of the Self Assessment exam questions, go back and re-study the necessary portions of the Information section, or ask you instructor for help. If you missed one or none of these problems, go on to step 5.

5. ____ Complete the Post Assessment section of the module. Show your answers to the instructor. It is recommended that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on to the next math module.

Information

REDUCTION OF COMPOUND NUMBERS

The principles of adding, subtracting, multiplying, and dividing compound numbers are outlined in the illustrative problems presented in this topic. Each problem is accompanied by its step-by-step solution. The units of measure chosen for the problems are feet and inches, but the principles demonstrated apply equally to compound numbers involving pounds and ounces, hours and minutes, and the like. Except in the case of the simplest addition and subtraction problems, the reduction (changing) of related but unlike units is an essential setp in working with compound numbers. This is so because only like units can be combined in an arithmetical operation. After this reduction has been accomplished, operations involving compound numbers can be performed in the conventional way.

Reduction from higher to lower denomination units

Problem: Reduce 13 feet to inches

Step 1. 1' = 12"
Step 2. 13 x 12 = 156"

Reduction from lower to higher denomination units

Problem: Reduce 216 inches to feet

Step 1. 12" = 1'
Step 2. 216" ÷ 12 = 18'

ADDITION OF COMPOUND NUMBERS

Problem: Add 2'7" and 8'10"

Step 1. Add the inch column.
7" + 10" = 17"

Step 2. Reduce the inches to feet and inches
17" = 1'5"
Write the 5" in the sum and carry the remaining 1' to the foot column

```
 2'7"
+8'10"
  17"
 (1')
 2'7"
+8'10"
11'5"
```

SUBTRACTION OF COMPOUND NUMBERS

Problem: Subtract 3'4" from 9'2"

```
 9'2"
-3'4"
```

Step 1. Since 4" cannot be subtracted from 2", borrow 12" from the 9' and add to the 2", thus changing 9'2" to 8'14'

Step 2. Subtract both columns
14" - 4" = 10"
8' - 3' = 5'

```
 8'14"
-3'4"
 5'10"
```

MULTIPLICATION OF COMPOUND NUMBERS BY WHOLE NUMBERS

Problem: Multiply 3'7" by 8

Step 1. Multiply the inches by 8.
7' x 8 = 56"

Step 2. Reduce the product to feet.
56" = 4'8"

Step 3. Multiply the number of feet in the multiplicand by 8

Step 4. Add the results of Steps 2 and 3.
4'8" + 24'8" =

```
 3'7"
 x 8
24'+4'8" = 28'8"
```

DIVISION OF COMPOUND NUMBERS BY WHOLE NUMBERS

Problem: Divide 31'3" by 15.

Step 1. Reduce the feet to inches. 31' = 372"

Step 2. Add the total number of inches. 3" + 372" = 375"

Step 3. Divide the sum by 15. 375" ÷ 15 = 25'

Step 4. Reduce the tuotient to feet. 25" = 2'1"

ADDITION AND SUBTRACTION OF COMPOUND MIXED NUMBERS

If the lowest-denomination units in an addition or subtraction problem involving compound numbers are expressed in fractions, we must first reduce the fractions to the lowest common denominator before proceeding with the calculation. The following addition problem illustrates this point.

Problem: Add 12'8-1/2", 17'4-3/8", 5'5-1/4", and 2'10-5/8".

Step 1. Reduce the fractions to terms of the lowest common denominator

Step 2. Add the fraction column and reduce the sum to inches. 4/8" + 3/8" + 2/8" + 5/8" = 14/8" 14/8" = 1-6/8" = 1-3/4". Write the fraction 3/4" in the sum and carry the 1" to the inch column.

```
LCD = 8
1/2 = 4/8
1/4 = 2/8
  (1")
12' 8-4/8"
17' 4-3/8"
 5' 5-2/8"
 2' 10-5/8"
```

Step 3. Add the inch column and reduce the sum to feet and inches. 1" + 8" + 4" + 5" + 10" = 28". Write the 4" in the sum and carry the 2' to the foot column.

Step 4. Add the foot column. 2' + 12' + 17' + 5' + 2' = 38'

(2')(1")
12' 8-4/8"
17' 4 -3/8"
5' 5-2/8"
2' 10-5/8"

MULTIPLICATION OF COMPOUND NUMBERS BY COMPOUND NUMBERS

To find an area for which both the length and width are expresses in compound numbers, one can multiply the compound numbers, but this can be time consuming, especially if fractions are involved. It is often sufficiently accurate to reduce the compound numbers to the nearest mixed denominate numbers to simplify multiplying them. For example, to multiply 2'6" by 8' 3-3/4" to find the area of a panel, change the 7" to 1/2' and 3-3/4" to 1/3'; then multiply 2-1/2' by 8-1/3'. In fact, for estimating purposes it would probably be sufficiently accurate to multiply 2-1/2' by 8-1/2'. If a more accurate answer is essential, reduce both compound numbers to feet and twelfths of a foot, then multiply the resulting denominate numbers; or reduce both compound numbers to inches, then multiply. The result will be square feet or square inches, depending upon the method used. (Remember that a square foot contains 144 square inches.)

DIVISION OF COMPOUND NUMBERS BY COMPOUND NUMBERS

Occasionally the need arises to divide one compound number by another compound number, for example to find out how many times one shorter length is included in another longer length, as in the problem that follows:

Problem: Divide 12'8" by 3'2".

Step 1. Reduce the feet to inches in each compound number. 12' = 144"; 3' = 36".

Step 2. Add the inches in each reduced compound number. 144" + 8" = 152"; 36" + 2" = 38".

Step 3. Divide the resulting denominate number. 152" ÷ 38" = 4. 4 x 3'2" = 12'8".

Note: Any remainder in such a problem will be in inches. For example, if the divisor in the above problem were 3'6" instead of 3'2", the answer would be 3 plus a remainder of 26".

Self Assessment

Write the answer to each problem in the corresponding space at the right.

1. Change 372" to feet. _____
2. Change 16'8" to inches. _____
3. Add 4'8", 17'3", 11'5", 44'2", and 32'10". _____
4. Subtract 23'8" from 57'2". _____
5. Subtract 28'11" from 32'10". _____
6. Multiply 3'8" by 9. _____
7. Multiply 22'4" by 37'11". _____
8. Divide 11'6" by 3. _____
9. Divide 19'2" by 3'10". _____
10. Add 7 hr. 18 min. and 3 hr. 47 min. _____

Self Assessment Answers

1. 31'
2. 200"
3. 110'4"
4. 33'6"
5. 3'11"
6. 33'
7. approximately 5.9 sq. ft.
8. 3'10"
9. approximately 4'9"
10. 11 hrs. 5 min.

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter of that answer in the space to the left of the problem.

1. ____ 9'6" + 3'6" =

   a. 13'0"
   b. 13'6"
   c. 14'0"
   d. 14'6"

2. ____ 6'3" + 6'8" + 5'1" =

   a. 17'0"
   b. 17'6"
   c. 17'9"
   d. 18'0"

3. ____ If the height of a ceiling above the floor is 9'6" and the distance from the floor to the top of the window casing is 6'11", what is the distance from the top of the casing to the ceiling?

   a. 2'6"
   b. 2'7"
   c. 2'9"
   d. 2'11"

4. ____ Three identical metal frames are needed to complete a glazing job. The following pieces of metal extrusion are required to make these frames: 8 pieces 10'7" long; 9 pieces 8'4" long; and 3 pieces 3'9" long. How many inches of the metal will be required for each frame?

   a. 572
   b. 614
   c. 681
   d. 724

5. ____ How many 16" lengths of hanger wire can be cut from a roll containing 97'4" of the wire?

   a. 73
   b. 75
   c. 77
   d. 80

6. ____ Four boards, each 12'9" in length, are laid end to end. What is their total length?

   a. 42'6"
   b. 45'0"
   c. 49'3"
   d. 51'0"

7. ____ The following pieces of material are cut from a stock of 10 pieces, each 21' long: 2 pieces 4' long; 3 pieces 6 1/3' long; and 4 pieces 54" long. How many feet of the material remain in stock?

a. 164
b. 165
c. 166
d. 167

8. ____ Metal trim for a job was purchased from two different suppliers. Company A supplied the following: 4 pieces 5'11" long; 9 pieces 12'2" long; and 18 pieces 6'9" long. Company B supplied the following: 19 pieces 1'3" long; 18 pieces 9'4" long; 2 pieces 1'10" long; 10 pieces 5'5" long; and 4 pieces 1'3" long. How much more trim was supplied by Company A than by Company B?

a. 1"
b. 2"
c. 10"
d. 20"

9. ____ A glass shop receives an order to replace the tops on 6 showcases. Each of these showcases requires a new piece of green felt 2" wide and 6'3" long under the rear edge of the glass. How many square inches of green felt will be needed to do the entire job?

a. 850
b. 900
c. 950
d. 1,000

10. ____ What is the total length in feet and inches of the following pieces of flashing: 2 pieces 18" long; 10 pieces 78" long; 1 piece 29" long; and 6 pieces 10" long?

a. 69'9"
b. 75'5"
c. 84'7"
d. 88'3"

11. ____ In making a batch of mortar, a workman used lime an an amount equal to 12 percent of the cement. How many pounds of lime are necessary if 995 lbs. of cement are used?

a. 119.4
b. 121.8
c. 123.5
d. 130.2

16.6

PERCENT

Goal:

The apprentice will be able to compute percentage problems.

Performance Indicators:

1. Change percent to decimal.
2. Change decimal to percent.
3. Change fractions to decimals.
4. Compute problems with percent.

Introduction

The word "percent," an abbreviation of the Latin "per centum," literally means "for each hundred" or "by the hundred." "Percentage" means the methods of expressing a part of a whole as hundredths of the whole. Thus, 12 percent means 12 parts of a whole that is thought of as consisting of 100 such parts; 100 percent means all 100 parts of the whole taken together; and 108 percent means all 100 parts of the whole plus 8 more such parts.

Since percents are expressions of the parts of a whole, they can be converted to common fractions or decimals: 12 percent is equivalent to 12/100 or 0.12; 100 percent is equivalent to 100/100 or 1.0; and 108 percent is equivalent to 108/100 (1-8/100) or 1.08. It can be seen that percents greater than 100 become mixed numbers in such conversions.

Skill in working with percents is necessary for estimating costs, discounts, and profit margins, and it is very useful in calculating proportions, for example in determining the relative amounts of materials needed for fluid mixture of a given composition.

Study Guide

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STEPS TO COMPLETION

1. ___ Familiarize yourself with the Goal and Performance Indicators on the title page of this module.

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5. ___ Complete the Post Assessment section of this module. Show your answers to the instructor. It is recommended that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on to the next math module.

Information

To change a percent to a decimal, remove the % sign, then place a decimal point two digits to the left of the number for the given percent. (If the percent is a mixed number, change the fraction to a decimal and place this value after the whole number.)

Use the decimal value for the given percent the same as any other decimals to perform the required mathematical operations.

To change a decimal to a percent, move the decimal point two digits to the right. Place the percent sign after this number.

Self Assessment

The bill for a certain job is $332.20. If the customer wishes to pay 15% on the original bill, what should she pay?

During the first four days of a work week, the total daily output reached 276, 320 342, and 286 welds of a certain type. The rejects each day of these totals were 5%, 4.5%, 6% and 5%, respectively. The weekly quota to meet a contract is 325 perfect welds per day. How many welds must be produced the fifth day to meet the schedule? (Assume that the rejects on the fifth day is the average percent of the other four days.)

Write the letter of the correct, or most nearly correct, answer in the blank at the left of each problem.

____ The fraction 9/16 is equivalent to what percent?

a. 9.16
b. 56
c. 56 1/4
d. 565

____ The fraction 3/32 is equivalent to what percent?

a. 3 1/32
b. 3 30/32
c. 9 3/8
d. 93 1/8

____ The fraction 9/32 is equivalent to what percent?

a. 28
b. 28 1/32
c. 28 3/32
d. 28 1/8

Self Assessment Answers

She should pay 332.20 X .15 or $49.83

490 welds

9/16 = c

3/32 = c

9/32 = d

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the space to the left of the problem.

1. ____ Expressed as a fraction in lowest terms, 43 3/4 percent is:

   a. 7/32
   b. 7/16
   c. 43/40
   d. 46/4

2. ____ Expressed as a fraction in lowest terms, 62 1/2 percent is:

   a. 5/8
   b. 6/8
   c. 62/80
   d. 62 1/2

3. ____ Expressed as a fraction in lowest terms, 83 1/3 percent is:

   a. 5/6
   b. 10/16
   c. 8/9
   d. 1 4/3

4. ____ A certain type of glass is composed of 63 percent silica sand, 23 percent soda ash, and 14 percent lime. The total batch of glass weighs 1,600 lbs. How many pounds of soda ash are in the batch?

   a. 224
   b. 368
   c. 472
   d. 592

5. ____ Two glaziers install 2,100 lights of glass, but 84 lights turned down by the inspectors have to be reputtied. What percent of the job has to be done over?

   a. 2
   b. 4
   c. 20
   d. 40

6. ____ The finished width of a certain shiplap sheathing board is 1 5/8". What is this width in decimal form?

   a. 1.525"
   b. 1.575"
   c. 1.580"
   d. 1.625"

7. ____ A roof has an area requiring 476 running feet of a certain kind of insulating material. If 28 percent is to be added for cutting and waste, how many running feet of the material should be ordered, to the nearest foot?

a. 606
b. 608
c. 609
d. 623

8. ____ A tilesetter purchases a table saw at $475 less separate discounts of 15 percent and 3 percent. What is his actual cost?

a. $389.65
b. $391.64
c. $392.74
d. $394.46

9. ____ A portable electric circular saw has a speed of 4,000 rpm under full load. Under no-load conditions, the saw's speed increases 15 percent. What is the no-load speed?

a. 4,250 rpm
b. 4,400 rpm
c. 4,550 rpm
d. 4,600 rpm

10. ____ The total cost of a new building is $35,450. If the cost of the roof is 2 percent of this total amount and if the roofing materials represent 27 percent of the cost of the roof, what is the cost of the roofing materials?

a. $152.97
b. $167.50
c. $175.21
d. $191.43

16.7

RATIO AND PROPORTION

Goal:

The apprentice will be able to compute ratio and proportion.

Performance Indicators:

1. Solve problems involving ratio and proportion.

Introduction

Problems in ratio and proportion are frequently encountered in the skilled trades. For example, a machinist employs the concepts of simple and compound ratio in solving problems relating to gearing, and a carpenter employs the concepts of ratio and proportion in working from blueprints or other scale drawings.

Study Guide

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Information

Ratio is a means of expressing a relationship between two or more things mathematically. A ratio is the quotient of two numbers, and it can therefore be expressed as a fraction. The fraction 3/4 expresses the ratio of three to four, which may also be written 3:4. Whan a ratio is expressed in words, the things being related and the numerical terms of the ratio are listed in the same order; for example, if a worker is told to mix sand and cement for a concrete batch in the ratio of three to one, he or she will know that the mixture must include three sacks of sand for every sack of cement, not the reverse.

Proportion is an expression of equality between two ratios. The fraction 3/4 is equal to the fraction 6/8; this is a statement of proportion. The relationship between these equivalents can also be written 3:4::6:8, which is read "three is to four as six is to eight." This simply means that three bears the same relationship to four that six does to eight. If all but one of the terms of a proportion equation are known, the remaining term can be found. This makes possible a useful short method for solving problems like those in which an object must be proportionally increased or reduced in size but where one of the needed dimensions is not known.

Self Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the space to the left of the problem.

1. ____ The ratio of the height of a building to the length of its shadow is 5 to 9. What is the height of the building if it casts a shadow 90' long?

   a. 50'
   b. 55'
   c. 60'
   d. 65'

2. ____ An architect indicates a 1/8" = 1'0' scale in the drawing of a swimming pool. What is this scale expressed as a ratio?

   a. 1:58
   b. 1:75
   c. 1:85
   d. 1:96

3. ____ A tile subcontractor prepares a shop drawing to a scale of 1" = 1'0". What is this scale expressed as a ratio?

   a. 1:10
   b. 1:12
   c. 1:14
   d. 1:16

4. ____ A contractor estimates that 10 cents of every dollar of his bid will be required for exterior and interior glazing of a building. What is the ratio of the glazing cost to the total building cost?

   a. 1:1
   b. 1:10
   c. 1:100
   d. 1:110

Self Assessment Answers

1. a

2. d

3. b

4. b

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the space to the left of the problem.

1. ____ On a tile job in which fireclay is to be used, a tilesetter tells his helper to mix mortar according to the following formula: 6 buckets of river sand, 1 bucket of fireclay, and 2 buckets of cement. What is the ratio of sand to fireclay in the mixture?

   a. 1:6
   b. 1:2
   c. 3:1
   d. 6:1

2. ____ Referring again to the above problem, what is the ratio of cement to sand in the mixture?

   a. 1:2
   b. 1:3
   c. 1:6
   d. 1:8

3. ____ What is the missing term in the proportion 46:30::92:x?

   a. 20
   b. 40
   c. 60
   d. 80

4. ____ What is the missing term in the proportion 42:x::30:2.5?

   a. 1.75
   b. 3.5
   c. 4.25
   d. 5.75

5. ____ If 5 cu. yd. of concrete cost $60, what will 3 cu. yd. cost?

   a. $36
   b. $42
   c. $48
   d. $54

6. ____ If ten cement masons can place and finish 6,400 sq. ft. of concrete sidewalk in four days, how many cement masons will be needed to place and finish 3,200 sq. ft. of concrete sidewalk in the same amount of time?

   a. three
   b. five
   c. seven
   d. nine

INSTRUCTIONAL LEARNING SYSTEMS

16.8

PERIMETERS, AREAS AND VOLUMES

Goal:

The apprentice will be able to compute areas and volumes of regular and irregular shaped objects.

Performance Indicators:

1. Compute area of a rectangle.
2. Compute area of a triangle.
3. Compute areas of irregular shaped objects.
4. Measure volumes of regular and irregular shaped objects.

Introduction

Problems involving the measurement of perimeters, areas, and volumes are frequently encountered on the job. A skilled worker in the construction trades, for example, may need to know not only the length and width of a room but also its perimeter and the areas of its floor, walls, and ceiling for estimating material and labor costs for interior finish work. He or she may also need to know the volume of air space of the room for heating and ventilating calculations. Measurements of perimeters, areas, and volumes are basic to every craft, and the apprentice must therefore become thoroughly familiar with the rules and procedures for making them.

Study Guide

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Information

MEASURING PERIMETERS

The perimieter of an object--the distance around it--is found by adding the lengths of all its sides; the perimeter of a building lot 60' x 180' is therefore 60' + 180' + 60' + 180', or 480'. The perimieter of the irregularly shaped structure in the plan view, Fig. D-1, will be found to be 68' if the dimensions of all its sides are added.

MEASURING AREAS

Measurements of areas are expressed in units of square measure--square inches, square feet, square yards, and the like. The area of a square or other rectangle is found by multiplying its length by its width. The result will always be in units of square measure. For example, the area of a plywood panel 4' wide by 8' long is 32 square feet.

Since a linear foot is equal to 12", a square foot (1 foot each way) contains 12" x 12", or 144 square inches. (See Fig. D-2.) Expressions of square measure must be read carefully if mistakes are to be avoided: note that 10-inch square (one square measuring 10" x 10") is not the same as 10 square inches (ten squares, each measuring 1" x 1").

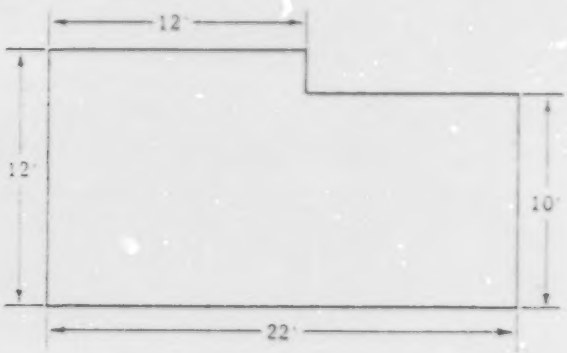


Fig. D-1 Perimeter measurement

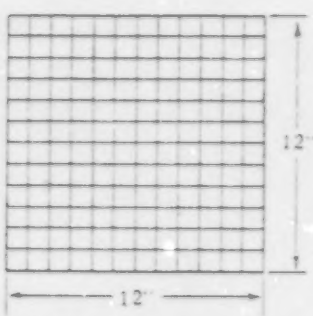


Fig. D-2 A 12-inch square (one square foot) contains 144 square inches

AREA OF A RECTANGLE

Multiplying two adjacent sides gives the area of a square or other rectangle. In a square, all four sides are of equal length and all four corners are right angles; other rectangles differ from the square in that their sides and ends are of unequal length. (See Figs. D-3A and D-3B.) A rectangle that is not a square is commonly called an oblong. Since all sides of a square are of equal length, the area of a square is found by multiplying any side by itself; the area of an oblong is found by multiplying its length by its height.

Any four-sided plane figure whose opposite sides are straight and parallel is a parallelogram. Squares and oblongs meet this definition, but the word parallelogram usually applies specifically to a four-sided plane figure whose oppostie sides are parallel but whose corners are not right angles. A parallelogram can be thought of as a rectangle with a triangle removed from one end and tacked onto the other end. (See Fig. D-3C.) To compute the area of a parallelogram, multiply base X height (altitude). The base of the parallelogram in Fig. D-3C is 14", and its altitude is 10"; therefore its area is 10" x 14", or 140 square inches.

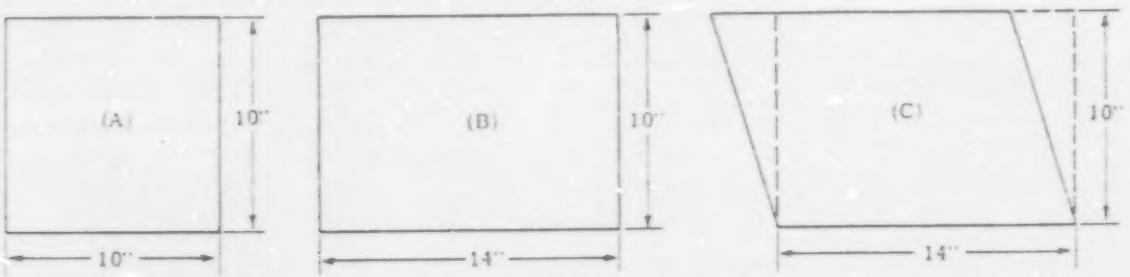


Fig. D-3. Four-sided plane figures: (A) square; (B) oblong; (C) parallelogram

AREA OF A TRIANGLE

A triangle is a plane figure with three sides, each side being a straight line. A square-cornered or right triangle has one right angle (Fig. D-4A). In an acute triangle, each of the three angles is less than a right angle (Fig. D-4B). An obtuse triangle has one angle that is greater than a right angle (Fig. D-4C).

Any triangle is really one-half of a rectangle (or one-half of a parallelogram, in the case of an acute or an obtuse triangle). This can be seen clearly in Fig. D-4A, where an identical but inverted right triangle is drawn above the shaded right triangle, making a rectangle. Similarily, "mirror-image" triangles could be joined to the acute and obtuse angles in Figs. D-4B and D-4C to make parallelograms.

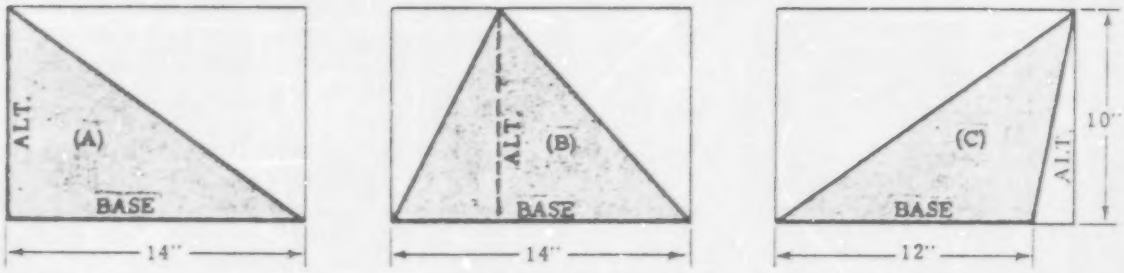
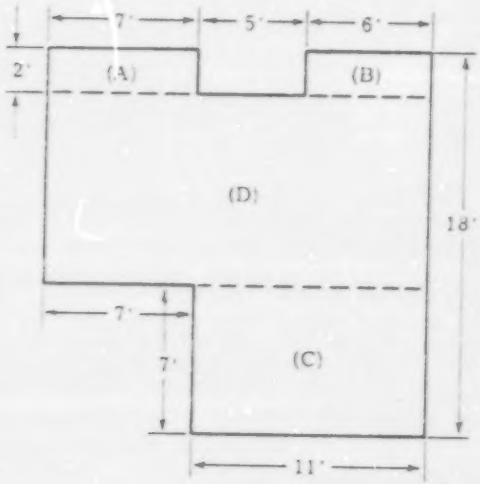


Fig. D-4. Triangles: (A) right; (B) acute; (C) obtuse

The area of a rectangle or a parallelogram is euqal to its length (base) times its height(altitude). Since a rectangle or a parallelogram can be made by joining two identical triangles, it follows that the area of any triangle is equal to one-half the product of its base and its altitude. The area of the right triangle in Fig. D-4A is therefore 70 square inches; the area of the acute triangle in Fig. D-4B is 70 square inches; and the area of the obtuse angle in Fig. D-4C is 60 square inches.

AREAS OF IRREGULAR SHAPES

Any skilled worker may occasionally find it necessary to determine the area of an irregularly shaped surface. For a practical problem of this kind, assume that a worker needs to determine the area of the floor in a room having a number of projections and recesses. He or she can compute the total floor area in either of two ways: he or she can divide the irregular floor shape into smaller rectangular shapes, then compute the areas of these rectangles and take their sum; or square out the irregular floor shape, compute the area of the resulting square, then subtract from that the areas of the cutouts. (See Fig. D-5.)

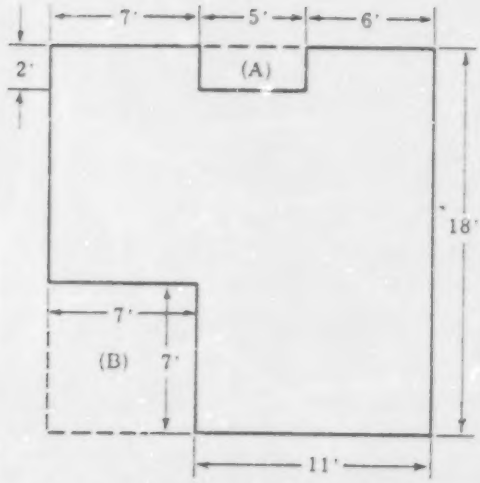


Method 1. Divide the floor area into rectangular units (A, B, C, and D); then compute the area of each unit and add the unit areas.

A) 7' x 2' = 14 sq. ft.
B) 6' x 2' = 12 sq. ft.
C) 7' x 11' = 77 sq. ft.
D) 9' x 18' = 162 sq. ft.
265 sq. ft.

Fig. D-5, 1

Method 1: A + B + C + D = 265 sq. ft.



Method 2. Enclose the floor area in a square; find the area of the square, then subtract the areas of the cutouts (units (A and B).

18' x 18' = 324 sq. ft.

A) 2' x 5' = 10 sq. ft.
B) 7' x 7' = 49 sq. ft.
59 sq. ft.

324 sq. ft.
-59 sq. ft.
265 sq. ft.

Method 2. A + B subtracted from total area - 265 sq. ft.

Fig. D-5, 2. Finding the area of an irregularly shaped floor

MEASURING VOLUMES

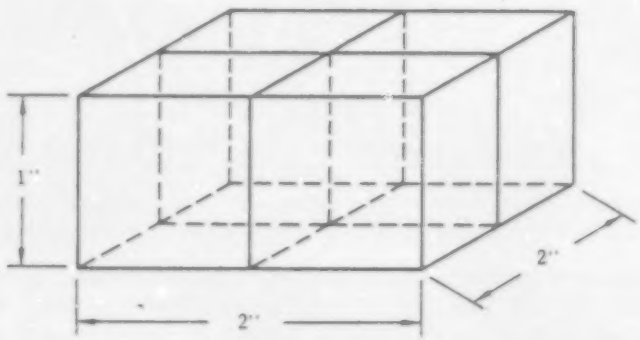
The plane figures described thus far in this topic have the dimensions of length and width only. Because solid objects have thickness as well as length and width, they occupy or enclose space. The amount of space taken by a solid object is its volume. Volume is commonly expressed in cubic measure--cubic yards, cubic feet, or cubic inches, for example--but it can also be expressed in liquid measure (gallons, quarts, pints or ounces) or dry measure (bushels or pecks). Volumes expressed in one kind of measure can be changed to volumes expressed in another measure by means of conversion constants. For example, a cubic foot is equal to 7.48 U.S. gallons, and a bushel is equal to 1.244 cubic feet.

To find the cubic measure of a body such as a cube or a box, where all the corner angles are right angles, multiply length times width times thickness. The result is expressed in cubic units. The dimensions of the box in Fig. D-6 are 2" x 2" x 1". The box therefore encloses (has a volume of) 4 cubic inches. As in the case of square measure, care must be taken in expressing cubic measure if mistakes are to be avoided; a 10-inch cube is not equivalent in volume to 10 inches.

If the shape of an object is such that its ends (or its top and bottom) are identical, parallel, and exactly opposite each other, and if the straight lines bounding the sides of the object are all parallel (as in the shapes shown in Fig. D-7), the volume of the object can be found by multiplying the area of one end (or of the top or bottom) by the length (or height) of the object. If for example the

the area of one end of the prism shown at the left in Fig. D-7 is 10 square inches and the length of prism is 15 inches, the volume of the prism will be 10 square inches x 15 inches, or 150 cubic inches.

Fig. D-6
Cubic measure



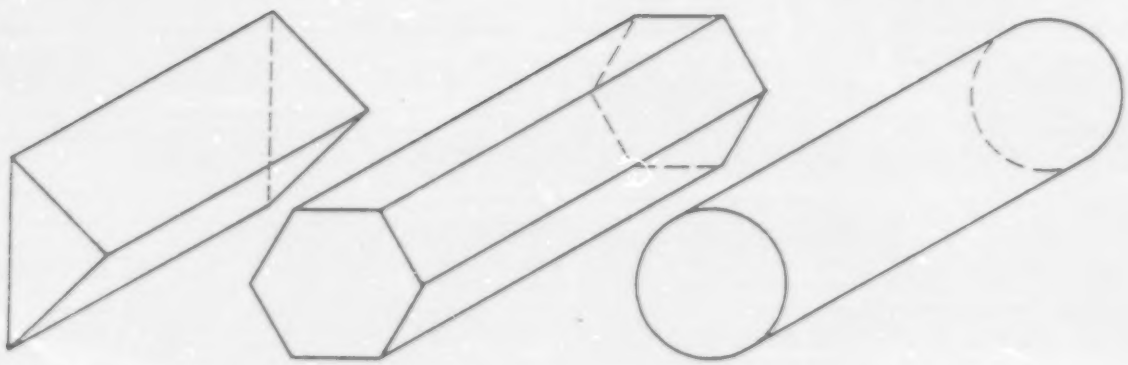


Fig. D-7. Solids with identical ends and straight sides

The volume of an irregularly shaped object can best be found by thinking of the object as being made up of a number of smaller solid shapes. (See Fig. D-8.) The separate volumes of these smaller shapes can then be computed and added to find the total volume.

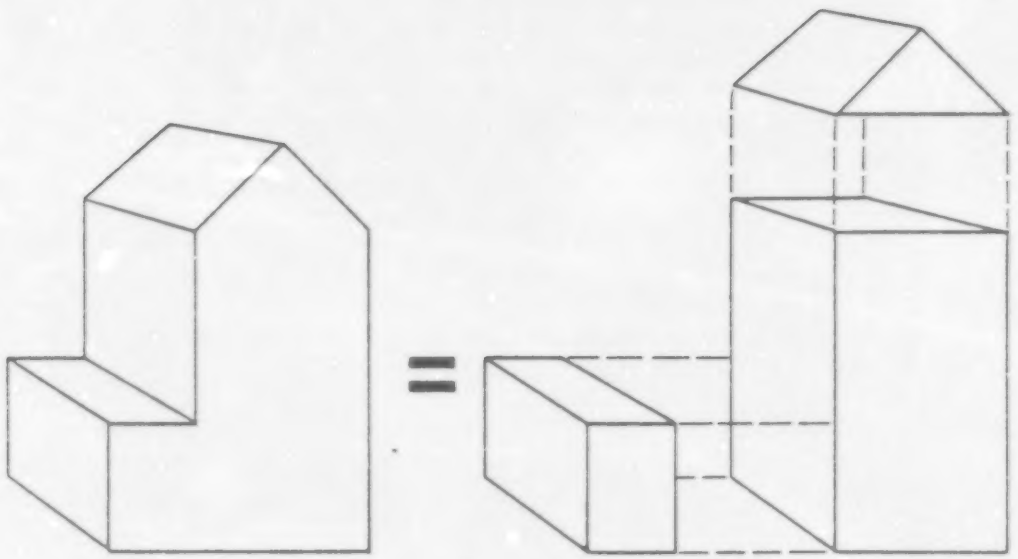


Fig. D-8. Finding the volume of an irregularly shaped object.

Self Assessment

Write the answer to each problem in the corresponding space at the left.

1. _____ What is the perimeter of a room 20' wide and 30' long?

2. _____ What is the perimeter of a room 16' square?

3. _____ What is the area, in square feet, of a floor 42' by 42'?

4. _____ What is the area, in square inches, of a 9" square floor tile?

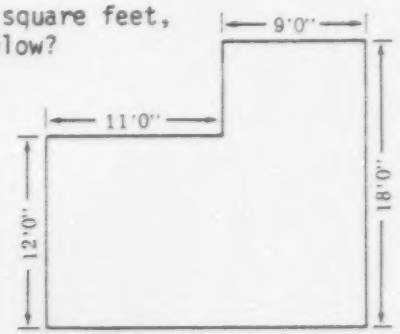
5. _____ What is the floor area, in square feet, of a room 15' long and 12' wide?

6. _____ What is the area, in square yards, of a rectangle 20' long and 9' wide?

7. _____ What is the area, in square inches, of a right triangle with a base of 8 1/2" and an altitude of 11 1/4"?

8. _____ What is the area, in square inches, of an acute triangle with a base of 8 1/2" and an altitude of 11 1/4"?

9. _____ What is the area, in square feet, of the floor shown below?



Self Assessment Answers

1. 100 ft.

2. 64 ft.

3. 1,764 sq. ft.

4. 81 sq. inches

5. 180 sq. ft.

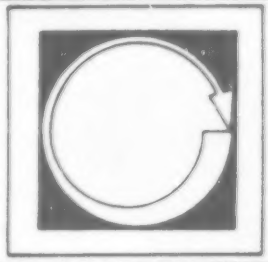
6. 6 2/3 sq. yards

7. 47.8 sq. inches

8. 47.8 sq. inches

9. 294 sq. ft.

Post Assessment



Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the blank space to the left of the problem.

1. ____ What is the perimeter of a rectangle 8' wide and 12' long?

   a. 32'
   b. 34 1/2'
   c. 37 1/2'
   d. 40'

2. ____ What is the perimeter of a rectangle 17 1/2' wide and 12 1/2' long?

   a. 40'
   b. 60'
   c. 80'
   d. 100'

3. ____ What is the perimeter of a rectangle 67'7" wide and 96'4" long?

   a. 237'10"
   b. 297'10"
   c. 327'10"
   d. 377'10"

4. ____ What is the area in square feet of a rectangle 32'9" wide and 52'6" long?

   a. 1,709.0
   b. 1,719.375
   c. 1,729.875
   d. 1,740.0

5. ____ An excavation for a basement is to be 40' long, 27' wide, and 8' deep. After 210 cu. yd. of dirt have been removed, how many cubic yards remain to be excavated?

   a. 90
   b. 110
   c. 115
   d. 120

6. ____ How many cubic feet of concrete are in a slab 12' long, 4' wide, and 1' thick?

   a. 40
   b. 42 1/2
   c. 44 1/2
   d. 48

7. ____ What is the volume in cubic inches of a 25" cube?

   a. 625
   b. 975
   c. 12,380
   d. 15,625

8. ____ What is the area in square feet of a room 14' square?

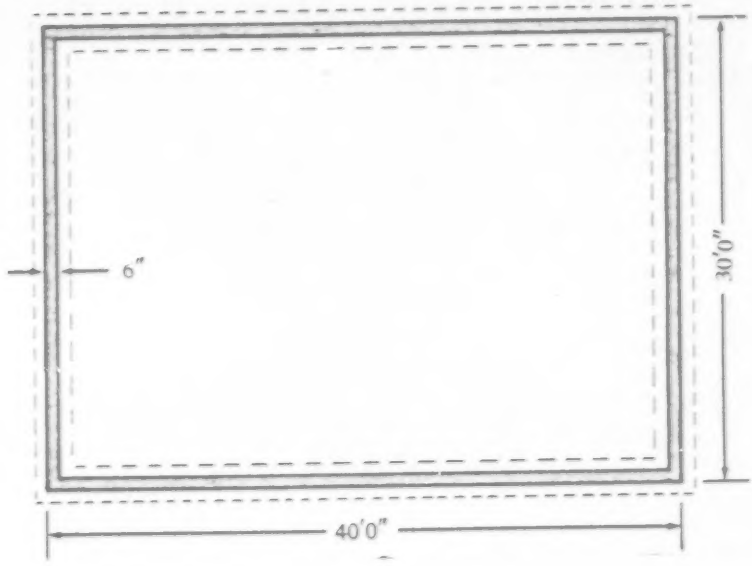
a. 56
b. 112
c. 196
d. 208

9. ____ How many cubic yards of concrete will be needed for a garage floor 20' x 32' x 4", allowing 3 cu. yd. extra for foundation walls and footings?

a. 4.9
b. 6.9
c. 7.9
d. 10.9

10. ____ How many cubic yards of concrete will be needed for the foundation walls and footings in the plan below if the walls are 6" thick and 18" deep, and if the footings (shown in dotted lines) will require 2 5/27 cu. yd. of concrete?

a. 6
b. 6 2/3
c. 7
d. 7 1/6



16.9

CIRCUMFERENCE AND AREA OF CIRCLES

Goal:

The apprentice will be able to compute problems involving circumference and area of circles.

Performance Indicators:

1. Find circumference of circle.
2. Find area of a circle.

Introduction

A knolwedge of the rules and procedures for finding the circumference and area of a circle is important for workers in the skilled trades. A construction worker, for instance, must make computations involving circular areas as well as straight-sided areas when working with structures like circular buildings, silos, or tanks. In a typical problem, he or she might find it necessary to determine the number of feet of insulating material needed for covering a cylindrical hot-water storage tank of a given diameter and height. The first step in solving this problem would be the calculation of the tank's circumference. The present module gives the information needed for finding the area and the circumference of a circle.

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

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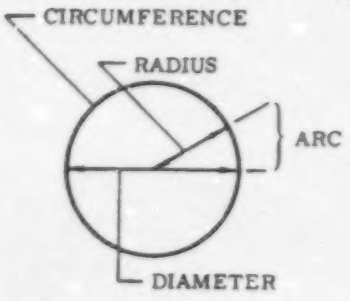
5. ____ Complete the Post Assessment section of the module. Show your answers to the instructor. It is recommended that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on to the next math module.

Information

FINDING THE CIRCUMFERENCE OF A CIRCLE

The perimeter of an object has been definded as the distance around it; circumference is the term employed for the perimeter of a circle or circular object. Any continuous part of a circumference is called an arc. The diameter of a circle is a straight line passing through the center of the circle and terminating at the circumference. The radius of a circle is a straight line drawn from the center of the circle to any point on the circumference; it is therefore equal to one-half the diameter. (See Fig. D-9).

Fig. D-9. Basic parts of a circle.



Regardless of the size of the circle, its circumference bears a constant relationship to its diameter. This ratio is 3.1416 to 1, or roughly 3 1/7 to 1. The number 3.1416 is a "constant" in mathematics; it has been given the symbol π (the Greek letter "pi"). If the diameter of a circle is known, the circumference can be computed by the following rule: Circumference = π x diameter (or, in short form, C = π x D).

The following example shows how the rule would be put to work in solving a practical problem:

Problem: Find the circumference of a circle whose radius is 10 feet.

Rule: $C = \pi \times D$

Step 1: Find the diameter
$D = 2 \times$ Radius (R)
$2 \times R = 20'$

Step 2: Multiply the diameter by π
$20' \times 3.1416$

Answer: $C = 62.832'$

By applying the rule for the circumference of a circle in another way, we can find the diameter or the radius of a circle if only the circumference is known. Since $C = \pi \times D$, it is also true that $D = C \div \pi$. The steps to be followed in solving a typical problem of this type are shown below:

Problem: Find the radius of a circle whose circumference is 34 inches.

Step 1: Find the diameter
$D = C \div \pi$, so $D = 34" \div 3.1416$, or $10.82"$

Step 2: Find the radius
$R = 1/2\ D$
$R = 10.82' \div 2$

Answer: $R = 5.41$

FINDING THE AREA OF A CIRCLE

To find the area of a circle, multiply the radius by itself, then multiply the resulting product by 3.1416 (π). The result, of course, will be in square measure. A number multiplied by itself is said to be squared; the symbol for squaring is a 2 following and slightly above the number to be squared. Thus 5^2 means 5 x 5, or 5 squared. The rule for finding the area of a circle, then, is: Area = $\pi \times R^2$. The application of this rule is illustrated in the following problem:

Problem: Find the area (A) of a circle whose radius is 20 feet.

Rule: $A = \pi \times R^2$

Step 1: Find the square of the radius.
$R^2 = 20' \times 20' = 400$ sq. ft.

Step 2: Multiply R^2 by π
3.1416×400 sq. ft.

Answer: $A = 1256.64$ sq. ft.

Self Assessment

Determine the word that belongs in each blank and write the word in.

1. The distance around the rim of a wheel is called the _____ of the wheel.

2. The diameter of a circle is a line passing through the _____ of the circle and terminating at the _____.

3. The symbol π, which is the Greek letter _____, stands for a mathematical constant having the numberical value _____.

4. The circumference of a circle is equal to π times the circle's _____.

5. The _____ of a circle is equal to one-half the circle's diameter.

6. The area of a circle is found by the following formula: $A = \pi \times$ ____.

7. The area of a circle is given in units of _____ measure.

8. If the radius of a circle is 5 inches, the circumference of the circle is _____ inches.

9. If the circumference of a circle is 95 inches, the diameter of the circle is _____ (to the nearest inch).

10. The area of a circle having a radius of 10 inches is _____.

Self Assessment Answers

1. circumference
2. center, edges
3. pi, 3.1416
4. diameter
5. radius
6. radius squared or R^2
7. square
8. 31.14 inches
9. 30 inches
10. 314 sq. inches

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the blank space to the left of the problem.

1. ____ The circumference of a hole 14" in diameter is how many inches?

   a. 43.98+ c. 58.39+
   b. 49.38+ d. 59.98+

2. ____ What is the area in square inches of a circular vent hole 30" in diameter?

   a. 607.58+ c. 807.58+
   b. 706.860 d. 857.850

3. ____ The area of a circular ceiling with a radius of 12' is how many square feet?

   a. 425.930 c. 493.390
   b. 452.39+ d. 857.850

4. ____ The area of a circular putting green with a radius of 17' is how many square feet?

   a. 907.92+ c. 1,002.720
   b. 909.72+ d. 1,007.92+

5. ____ A pole-hole in the second-story floor of a firehouse has a radius of 22". What is its circumference in inches?

   a. 123.230 c. 138.23+
   b. 132.32+ d. 148.320

6. ____ The area of a circular swimming pool with a radius of 10' is how many square feet?

   a. 304.16+ c. 341.46+
   b. 314.16+ d. 364.16+

7. ____ The area of a circular skating rink with a radius of 40' is how many square feet?

   a. 5,026.56+ c. 5,206.560
   b. 5,062.650 d. 5,506.26+

8. ____ A merry-go-round at an amusement park has a radius of 33'. What is its circumference in feet?

a. 179.04+
b. 197.34+
c. 206.34+
d. 237.04+

9. ____ A water tank has a diameter of 8'6". What is its circumference in feet?

a. 20.70
b. 23.33+
c. 25.250
d. 26.70+

10. ____ What is the area of a circular floor with a diameter of 10'6", to the nearest square foot?

a. 85
b. 86
c. 87
d. 88

16.10

AREAS OF PLANE FIGURES

VOLUMES OF SOLID FIGURES

Goal:

The apprentice will be able to compute problems involving areas of plane figures and volumes of solid figures.

Performance Indicators:

1. Compute area of parallelograms, trapezoids, triangles, polygons, circles and ellipses.
2. Compute volumes of cubes, prisms, cylinders, cones, pyramids and spheres.

Introduction

The previous modules, specifically the last two, have demonstrated the importance of math and its application in solving problems which apprentices are faced with daily. Some types of mathematical problems have not been covered in the previous modules. This module introduces several new formulas for determining areas and volumes of "out of the ordinary" or odd-shaped figures.

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

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Information

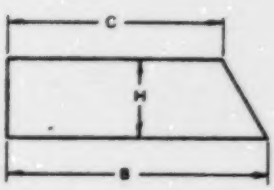
AREAS OF PLANE FIGURES

PARALLELOGRAM

$A = B \times H$

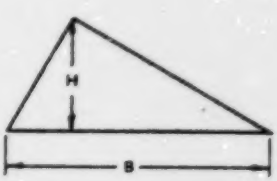
TRAPEZOID

$A = \frac{B + C}{2} \times H$



TRIANGLE

$A = \frac{B \times H}{2}$



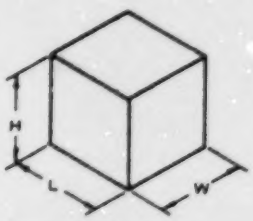
REGULAR POLYGON

$A = \frac{\text{SUM OF SIDES (S)}}{2} \times R$

VOLUMES OF SOLID FIGURES

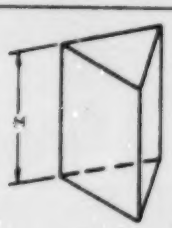
RECTANGULAR SOLIDS

$V = L \times W \times H$



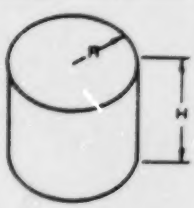
PRISMS

V = AREA OF END x H



CYLINDER

$V = \pi R^2 \times H$



CONE

$V = \frac{\pi R^2 \times H}{3}$

CIRCLE

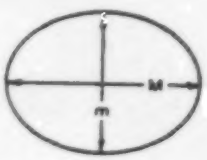
$A = \pi R^2$

$A = .7854 \times D^2$

$A = .0796 \times C^2$

ELLIPSE

$A = M \times m \times .7854$

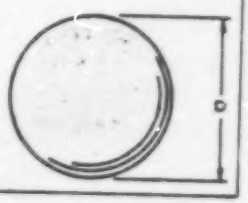


PYRAMIDS

$V = \text{AREA OR BASE} \times \frac{H}{3}$

SPHERE

$V = \frac{1}{6} \times \pi D^3$



Formulas for calculating areas or volumes of typical geometric shapes.

Self Assessment

Referring to the Information section, select your own numbers for the various bases, heights, lengths, widths, etc., and work out at least one formula for each of the 12 area and volume figures on the Information sheet.

Self Assessment Answers

The problems completed by students working on this module will be evaluated individually by the instructor.

Post Assessment

Referring to the Information section of this module, answer the following questions.

1. What is the volume of the cylinder if the radius (R) is 6 inches and the height is 8 inches? _____

2. What is the volume of the sphere if D is 11.4 inches? _____

3. What is the area of the regular polygon if each side is 2.5 inches and the R (radius) is 3.6 inches? _____

4. What is the total volume of the cylinder and the cone if the height of each is 9 inches, and the R (radius) of each is 4.5 inches? _____

16.11

METRICS

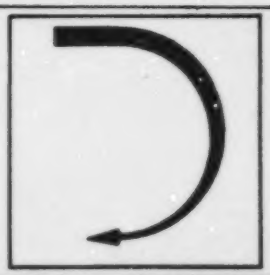
Goal:

The apprentice will be able to make conversions between the English and metric systems of measurement.

Performance Indicators:

1. Convert English to metric measurements.
2. Convert metric to English measurements.

Introduction



Through the years more and more countries have begun using the metric system. The United States is changing from the English FPS (Foot-Pound-Second) system to SI metrics. It is therefore important that we become familiar with the metric units and their relationship to the familiar English units.

Study Guide

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Information

The official name of the new metric system is "System International de Unite." Its abbreviation is "SI."

Although this module will not cover all of it, the following seven areas are those in which metrics come into play:

Quantity	SI Unit	SI Symbol
Length	metre	m
Mass (weight)	kilogram	kg
Time	second	s
Temperature	degree Kelvin	K
Electric current	ampere	A
Luminous intensity	candela	cd
Amount of substance	mole	mol

The area of measurement of length and distance is our primary concern here. Here are a few fundamentals of the metric system:

1 inch = 25.4 millimeters
= 2.54 centimeters
1 foot = 30.48 centimeters
= 3.048 decimeters
= 0.3048 meters

10 millimeters = 1 centimeter
10 centimeters = 1 decimeter
10 decimeters = 1 meter
10 meters = 1 decameter
10 decameters = 1 hectometer
10 hectometers = 1 kilometer

CONVERSIONS

The following information provides us with all we need to know about converting our system of inches, feet, yards, etc. to metric values:

inch x 25.4 = mm
inch x 2.5 = cm
inch x .025 = m
foot x 30.5 = cm
foot x 0.305 = m
yard x 0.91 = m
mile x 1.6 = km

The following information enables us to convert metric values to inches, feet, yards, etc.:

millimeters (mm) x 0.039 = inches
centimeters (cm) x 0.39 = inches
meters (m) x 39.4 = inches
centimeters x 0.33 = feet
meters x 3.28 = feet
meters x 1.09 = yards
kilometers (km) x 0.62 = miles

Example: A board is 46 inches long. How many centimeters long is it?
The table tells us that if we want to convert inches to centimeters, we multiply the number of inches by the converstion factor of 2.5.
Answer: 46 inches x 2.5 = 115 cm

Example: A Swiss watch measures 21 millimeters across its face. How many inches is it?
The table tells us that if we want to convert millimeters to inches, we multiply the number of millimeters by the converstion factor of .039.
Answer: 21 mm x .039 = .819 inches

Self Assessment

Complete the phrases below, referring to the Information section as necessary.

1. To determine how many millimemters are in an inch, you multiply by _____.
2. There are _____ centimeters in a meter.
3. _____ cm equals one inch.
4. A centimeter is _____ times as large as a mm.
5. A mm is _____ the size of a cm.
6. To determine how many cm are in a foot you would multiply _____ x _____ inches.
7. To determine how many millimeters are in a centimeter you would _____ by 10.
8. A meter consists of _____ feet.
9. A meter consists of _____ inches.
10. There are _____ mm in a meter.

Self Assessment Answers

1. 25.4
2. 100
3. 2.54
4. 10
5. one-tenth (1/10)
6. 2.5, 12
7. multiply
8. 3.28
9. 39.4
10. 1,000

Post Assessment

Compute the answers to the following problems and write the answers in the blanks.

1. ? inches = _____ cm
2. 6.5 yards = _____ meters
3. 6.5 yards = _____ cm
4. 12.7 cm = _____ inches
5. 7 feet = _____ meters
6. 1 inch = _____ cm
7. 1 cm = _____ mm
8. 1 mm = _____ cm
9. 1 foot = _____ cm
10. 1500 cm = _____ ft.